Available online at www.sciencedirect.com

ScienceDirect

Procedia Economics and Finance 5 (2013) 571 – 580

Procedia Economics and Finance

www.elsevier.com/locate/procedia

International Conference on Applied Economics (ICOAE) 2013

Analysing the CO_2 Emissions Function in Malaysia: Autoregressive Distributed Lag Approach

Mohamed Ibrahim Mugableh[a]*

[a] Graduate Business School, Universiti Tenaga Nasional (UNITEN), Kajang-Selangor, 43000, Malaysia.

Abstract

The main purpose of the current article is to re-analyse the CO_2 emissions function (i.e., gross domestic product and energy consumption) in Malaysia using annual time-series data over the [1971−2012] period. The paper employs the autoregressive distributed lag approach to identify the co-integrating relationships and estimate the equilibrium relationships. The validity of the environmental Kuznets curve hypothesis in the Malaysian economy has been tested to explore the relationship between gross domestic product per capita and CO_2 emissions per capita. The empirical results indicate the existence of co-integrating relationships among variables in the CO_2 emissions model.

Kewwords: ARDL Approach; CO_2 Emissions Function; EKC Hypothesis; Malaysia.

1. Introduction

During the past two decades, numerous studies have examined the equilibrium relationships between energy consumption (EC) and its determinants (see, *inter alia*, Bekhet & Othman, 2011; Belloumi, 2009; Islam et al., 2013; Narayan & Popp, 2012; Ouedraogo, 2013; Shahbaz et al., 2012; Shahiduzzaman & Alam, 2012). In addition, numerous studies have explored the relationships between carbon dioxide (CO_2) emissions and its determinants (e.g., Alam et al., 2012; Ang, 2008; Chang, 2010; Fei et al., 2011; Hussain et al., 2012; Menyah & Wolde-Rufael, 2010; Narayan & Narayan, 2010; Pao & Tsai, 2010; Park & Hong, 2013; Soytas & Sari, 2009; Wang, 2012). The findings showed that the determinants (i.e., consumer price index (CPI), gross domestic product (GDP), foreign direct investment (FDI), financial development (FD), real gross domestic product (RGDP), population (POP), per capita-GDP, and RGDP) significantly influenced EC and CO_2 emissions functions.

* Corresponding author. Tel.: +60129247480; fax: +0-000-000-0000 .
E-mail address: mugableh83@yahoo.com.

doi:10.1016/S2212-5671(13)00067-1

However, the main objective of the current paper is to re-analyse the hypotheses of equilibrium relationships among CO_2 emissions and its determinants rather than the determinants of EC in Malaysia. To the best of the author's knowledge and belief, the originality of this paper stems from three factors. First, it examines the equilibrium relationships among CO_2 emissions per capita, GDP per capita, and EC by utilizing the autoregressive distributed lag (ARDL) approach. Second, it uses long span of the Malaysian annual time-series data in constant 2005 bases for the [1971−2012] period. Finally, it re-evaluates the findings of Arouri et al. (2012), Fodha and Zaghdoud (2010), and Halicioglu (2009) in the Malaysian economy. These studies have evaluated the validity of the inverse-U shaped curve (i.e., environmental Kuznets curve (EKC) hypothesis). This hypothesis stated that, as the economic growth indicator increases, the greenhouse gases (GHGs) also increase during the first stage, before declining at the turning point. The paper is organized as follows: Section 2 presents an overview of the Malaysian economy followed by a discussion of previous studies in Section 3. Data and methodology are discussed in Section 4. The results analyses and concluding remarks are provided in Section 5 and Section 6, respectively.

2. Malaysian Economy Overview

Over the last few decades, EC in Malaysia has increased considerably, thereby inducing the amount of CO_2 emissions. In July 2009, the Malaysian government launched its national green technology policy, which was concerned with the issues of EC, CO_2 emissions, and RGDP. The objective of this policy was to ensure sustainable RGDP and increase EC while reducing CO_2 emissions into the atmosphere (UNFCCC, 2009). The climate change performance index was very poor and ranked Malaysia 49th out of the biggest 61 most polluted countries (Climate Change Performance Index Report, 2012). In addition, the CO_2 emissions in Malaysia recorded an annual growth rate of 4.6% for the [1971−2012] period (see Figure 1). These results imply that the Malaysian government relaxed into a pattern of continuous growth in CO_2 emissions.

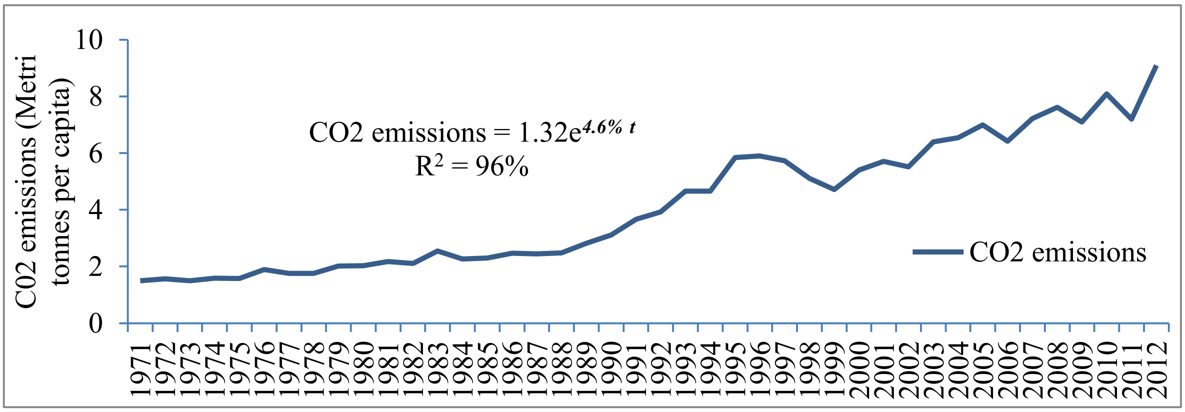

Figure 1: Malaysian carbon dioxide emissions for the [1971−2012] period.
Source: World Bank (2013), retrieved from: *http://data.worldbank.org/country/malaysia.*

Figure 2 shows that the Malaysian RGDP reached 5.9% for the [1980−2012] period and should continue growing at approximately 7% per annum to reach the 2020 vision and structuring the Malaysian development policies (Bekhet, 2013; Ministry of Finance, 2012). A large amount of energy should be consumed to achieve this vision, whereas EC registered an annual growth rate of 4.2% for the [1971−2012] period (see Figure 3). As such, the CO_2 emissions growth rate was higher than the EC growth rate, which is necessary for achieving the desired RGDP in Malaysia.

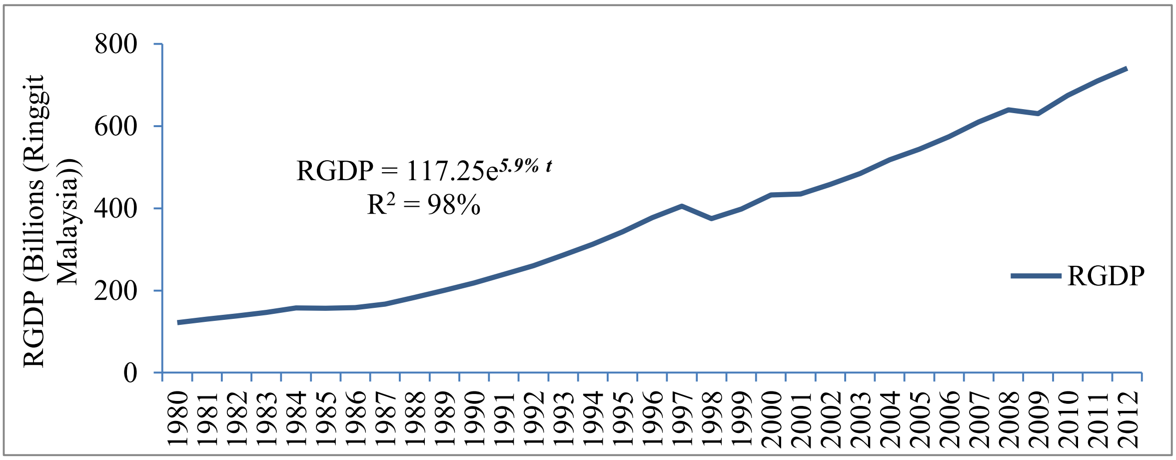

Figure 2: Malaysian real gross domestic product for the [1980−2012] period.
Source: IMF (2013), retrieved from: *http://www.imf.org/external/pubs/ft/weo/2012/02/weodata/index.aspx*.

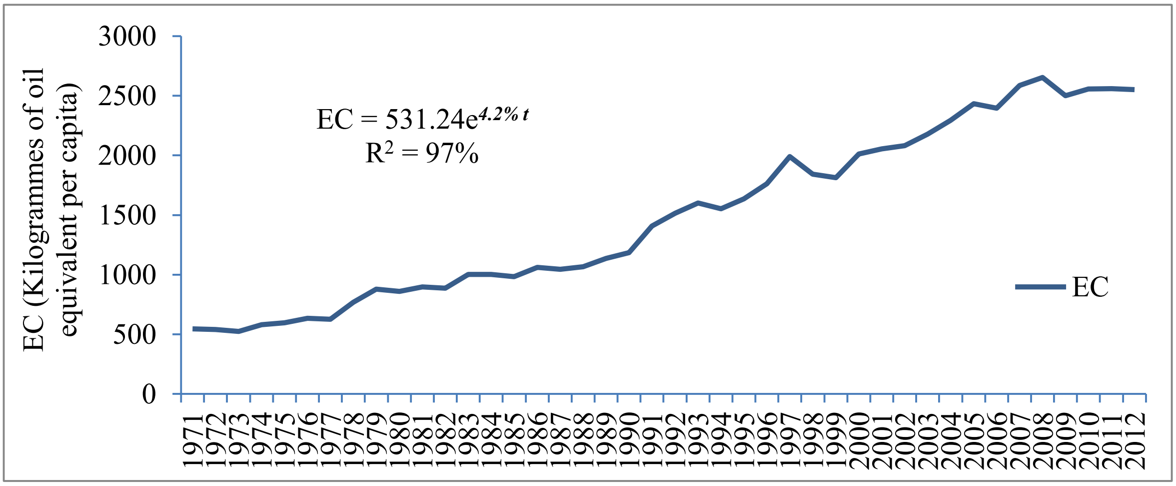

Figure 3: Malaysian energy consumption for the [1971−2012] period.
Source: World Bank (2013), retrieved from: *http://data.worldbank.org/country/malaysia*.

3. Previous Studies

Several previous studies have examined the determinants of EC and CO_2 emissions functions using time-series models. This section classifies these previous studies into two categories: studies that conducted using the determinants of the EC function and studies using the determinants of the CO_2 emissions function.

3.1. Determinants of the energy consumption function

By applying the vector error correction model (VECM), Bekhet and Othman (2011) analyzed the long-run equilibrium relationships among electricity consumption, CPI, GDP, and FDI using the Malaysian annual time-series data for the [1971−2009] period. The findings revealed long-run equilibrium relationships among the examined variables. For the same country, Islam et al. (2013) utilized ARDL approach to examine the long-run equilibrium relationships among EC, FD, RGDP, and POP using annual time-series data for the [1971−2009] period. The results revealed long-run equilibrium relationships among the identified variables. By implementing VECM, Narayan and Popp (2012) examined the long-run equilibrium relationships between EC and RGDP for 93 countries. The results only indicated long-run equilibrium relationships between EC and RGDP in the G6 countries: France, the USA, Germany, the UK, Italy, and Japan. Ouedraogo (2013) investigated the long-run equilibrium relationships between EC and GDP by using a Panel co-integration test and VECM in 15 African countries for the [1980−2008] period. The findings showed a long-run equilibrium relationship between EC and GDP. By utilizing annual time-series data for the [1972−2011] period, Shahbaz et al. (2012) examined the long-run equilibrium relationships among renewable EC, non-renewable EC, and RGDP using ARDL approach. However, the results showed a long-run equilibrium relationship among the investigated variables. Shahiduzzaman and Alam (2012) analysed the long-run equilibrium relationships between RGDP and EC using VECM and annual time-series data for the [1960−2009] period. The findings implied a long-run equilibrium relationship between RGDP and EC.

3.2. Determinants of the carbon dioxide emissions function

Alam et al. (2012) used annual time-series data for the [1972−2006] period to analyse the long-run equilibrium relationships among EC, ELC, CO_2 emissions, and RGDP in Bangladesh. The ARDL approach findings showed a positive long-run equilibrium relationship among the examined variables. Using the same approach, Ang (2008) explored the long-run equilibrium relationships among EC, CO_2 emissions, and per capita RGDP by utilizing the Malaysian annual time-series data for the [1971−1999] period. The findings showed long-run equilibrium relationships among the inspected variables. The results also demonstrated that CO_2 emissions and EC were positively associated with per capita RGDP in the long-run and short-run. Fodha and Zaghdoud (2010) analysed the long-run equilibrium relationships among sulphur dioxide (SO_2) emissions, CO_2 emissions, and GDP per capita by employing annual time-series data for the [1961−2004] period. The results indicated long-run equilibrium relationships among SO_2 emissions, CO_2 emissions, and GDP per capita. However, the results did not establish the existence of EKC hypothesis for CO_2 emissions−GDP, although they did confirm the existence of EKC hypothesis for SO_2 emissions−GDP in Tunisia. Halicioglu (2009) explored the long-run equilibrium relationships among CO_2 emissions, EC, RGDP, and FDI using ARDL approach and annual time-series data for the [1960−2005] period. The results showed the existence of long-run equilibrium relationships among the scanned variables. In addition, the findings implied that the EKC hypothesis did not exist for CO_2 emissions−GDP in Turkey.

4. Data and Methodology

The current paper employs a long span of annual time-series data tacking the [1971−2012] period into consideration. The data were obtained from a single source – namely the World Bank's, development indicators databases (*http://data.worldbank.org/country/malaysia)*. However, the CO_2 emissions in metric tonnes are the main component of GHGs in Malaysia; GDP per capita in thousands of Ringgit Malaysia represents the Malaysian economic growth indicator; and EC per capita in kilogrammes of oil equivalent signposts the energy sector indicator in Malaysia. All the variables were transformed into natural logarithmic forms (i.e., LCO_{2t}, $LGDP_t$ & LEC_t).

The existing paper analyses the equilibrium relationships among CO_2 emissions, GDP, and EC by adopting three steps. First, it starts by detecting the integration levels of variables via the Kwiatkowski, Phillips, Schmidt, and Shin, KPSS (1992) test. Second, the ARDL approach is used to test the co-integration and estimate the equilibrium relationships among variables in models. Finally, it evaluates the validity of the EKC hypothesis in the Malaysian economy. This paper employs the ARDL approach due to its superior statistical procedures in small sample sizes compared to VAR and VEC models. Moreover, this approach overcomes the problem of integration levels, as this approach could be applied irrespective of the variables are *I(1)* or *I(0)* or mutually co-integrated. The ARDL approach can be framed as in Equations. (1), (2), and (3):

$$\Delta LCO2_t = \beta_1 + \delta_{11} LCO_{2t-1} + \delta_{12} LGDP_{t-1} + \delta_{13} LEC_{t-1} + \sum_{r=1}^{h} v_{11} \Delta LCO_{2t-r} + \sum_{n=1}^{h} v_{12} \Delta LGDP_{t-n} + \sum_{a=0}^{h} v_{13} \Delta LEC_{t-a} - \tau_1 ecm_{t-1} + \varepsilon_{1t} \quad \textbf{(Equation. 1)}$$

$$\Delta LGDP_t = \beta_2 + \delta_{21} LGDP_{t-1} + \delta_{22} LCO_{2t-1} + \delta_{23} LEC_{t-1} + \sum_{r=2}^{h} v_{21} \Delta LGDP_{t-r} + \sum_{n=1}^{h} v_{22} \Delta LCO2_{t-n} + \sum_{a=0}^{h} v_{23} \Delta LEC_{t-a} - \tau_2 ecm_{t-1} + \varepsilon_{2t} \quad \textbf{(Equation. 2)}$$

$$\Delta LEC_t = \beta_3 + \delta_{31} LEC_{t-1} + \delta_{32} LGDP_{t-1} + \delta_{33} LCO_{2t-1} + \sum_{r=1}^{h} v_{31} \Delta LEC_{t-r} + \sum_{n=2}^{h} v_{32} \Delta LGDP_{t-n} + \sum_{a=2}^{h} v_{33} \Delta LCO_{2t-a} - \tau_3 ecm_{t-1} + \varepsilon_{3t} \quad \textbf{(Equation. 3)}$$

Here β_i (i= 1,.... 3) denotes the intercept terms. v_{ij} (i,j= 1,…., 3) represent the short-run coefficient. τ_i (i= 1,…. 3) denotes the coefficients of error correction terms, i.e., (ecm_{t-1})s. ε_{it} (i= 1,…. 3) stands for the error terms. *h* represents the lag length that selected using AIC. *r, n & a* denote the lag orders. δ_{ij} (i,j= 1,…, 3) indicate the long-run coefficients that are used for testing the co-integration. Pesaran et al. (2001) introduced two types of F-statistics (i.e., the OLS bounds F-statistics values and the bounds F-statistics critical values). They developed statistical tables to cover only two types of integration levels: *I(0)* and *I(1)*. The OLS bounds F-statistic value (i.e., the calculated F-statistic value) is compared with the bounds F-statistic critical value to determine the decision of co-integration. Specifically, if the calculated F-statistic value is greater than the upper bounds F-statistic critical value [*I(1)]*, the decision is to reject H_0: $\delta_{ij} = 0$ (Equations. 1-3), thus the variables in models are co-integrated. If the calculated F-statistic falls between the bounds F-statistics critical values [*I(1)* and *I(0)]*, the decision to either accept or reject H_0 is inconclusive.

5. Results Analyses

5.1. Stationarity test

Table 1 shows that LCO_{2t}, $LGDP_t$, and LEC_t are found to be stationary at *I(1)*, thus, the bounds F-statistics would be employed for testing the co-integration.

Table 1. *Stationarity Test Results.*

Integration	Variables	KPSS test statistics	KPSS asymptotic critical values		
			1%	5%	10%
I(1)	LCO_{2t} $LGDP_t$ LES_t	0.14^{*} 0.16^{**} 0.19^{**}	0.22	0.15	0.12

Notes: (1) 14 bandwidths used by employing Bartlet Kernel to conduct KPSS test statistics. (2) *, ** denote the significance at the 10% and 5% significance levels, respectively. (3) KPSS test was conducted using E-views econometric software package version *7.2*.

5.2. Co-integration test

Table 2 reveals that H_0 of no co-integration among variables in the LCO_{2t}, $LGDP_t$ and LEC_t models is rejected. In the LCO_{2t} model, the OLS bound F-statistics value (i.e., 3.75) falls between the bounds F-statistics critical values (i.e., 3.73 and 4.90) at the 2.5% significance level. Thus, the variables in the LCO_{2t} model are co-integrated. On the other hand, the OLS bound F-statistics values in the $LGDP_t$ and LEC_t models are 9.29 and 13.58, respectively, which are higher than [*I(1)* = 5.62] at the 1% significance level. Therefore, the variables in the $LGDP_t$ and LEC_t models are co-integrated. These results are confirmed with earlier papers' findings (e.g., Ang, 2008; Fodha & Zaghdoud, 2010; Halicioglu, 2009).

Table 2. *Co-integration Test Results.*

Bound F-statistics critical values: Intercept & no trend:							
10% significance level		5% significance level		2.5% significance level		1% significance level	
I(0)	*I(1)*	*I(0)*	*I(1)*	*I(0)*	*I(1)*	*I(0)*	*I(1)*
2.71	3.80	3.22	4.38	3.73	4.90	4.39	5.62

OLS Bound F-statistics values:

Models	Calculated F-statistics	Decision
LCO_{2t}	3.75^{*}	Co-integrated
$LGDP_t$	9.29^{**}	Co-integrated
LEC_t	13.58^{**}	Co-integrated

Notes: (1) The bound F-statistics critical values obtained from Pesaran and Pesaran (2009, p. 544) statistical Tables. (2) *, ** represent the significance at the 2.5% and 1% levels, respectively. (3) The Output of OLS Bound F-statistics values extracted from Micro-fit econometric software package version *4.1*.

5.3. Equilibrium relationships analyses

Table 3 demonstrates that LEC_t is positively associated with the LCO_{2t} model at the 1% significance level in the long-run and short-run. That is, if there is 1% increase in LEC_t, the LCO_{2t} model increases by 165% in the long-run and 109% in the short-run, and vice versa. Thus, the increase of LEC_t raises the LCO_{2t} model in long-run and short-run. These results are consistent with the earlier findings of Ang (2008), who focused on the Malaysian economy.

Table 3. *Equilibrium Relationships Analyses for the LCO_{2t} Model.*

41 observations used for estimating the long-run relationships in the LCO_{2t} model.					
Variables	Coefficients	Standard errors	T-ratios	P-values	Significance levels
Intercept term	-1.78	0.34	-5.30	0.00	1%
$LGDP_{t-1}$	2.28	0.34	6.71	0.00	1%
LEC_{t-1}	1.65	0.40	-5.30	0.00	1%
40 observations for estimating the short-run relationships and ecm_{t-1} in the ΔLCO_{2t} model. The selection of ARDL (1, 1 & 0) approach is based on AIC.					
Variables	Coefficients	Standard errors	T-ratios	P-values	Significance levels
Intercept term	-1.18	0.35	-3.42	0.00	1%
ΔLCO_{2t-1}	0.34	0.16	2.06	0.05	5%
$\Delta LGDP_t$	0.37	0.27	1.38	0.18	Insignificant
$\Delta LGDP_{t-1}$	2.21	0.67	3.30	0.00	1%
ΔLEC_t	1.09	0.37	2.93	0.00	1%
ecm_{t-1}	-0.66	0.16	-4.00	0.00	1%

Diagnostic tests: χ^2 Autocorrelation = 0.38[0.54]; χ^2 Ramsey Reset =0.07[0.79]; χ^2 Heteroscedasticity = 0.4[0.5] χ^2 Normality = 0.10[0.95]; $\overline{R}^2$ = 0.89; R^2 = 0.90; F-statistics = 12.17 (0.00).

Notes: (1) Figures in parentheses represent the p-values of F-statistics. (2) Figures in brackets denote the p-values of the chi-square (χ^2). (3) AIC represents Akaike information criterion that calculate the lag length and orders. (4) The output sourced from Micro-fit econometric software package version *4.1*.

However, Table 4 implies that LEC_t is positively associated with the $LGDP_t$ model in the long-run and short-run at the 1% significance level. If there is 1% increase in LEC_t, the $LGDP_t$ model increases by 166% in the long-run and 92% in the short-run, and vice versa. These findings are consistent with the earlier results of Alam et al.'s (2012) study in Bangladesh.

Table 4. *Equilibrium Relationships Analyses for the $LGDP_t$ Model.*

41 observations used for estimating the long-run relationships in the $LGDP_t$ model.					
Variables	Coefficients	Standard errors	T-ratios	P-values	Significance levels
Intercept term	-1.30	0.33	-3.97	0.00	1%
LCO_{2t-1}	- 0.40	0.21	-1.87	0.07	7.5%
LEC_{t-1}	1.66	0.27	6.04	0.00	1%
40 observations for estimating the short-run relationships and ecm_{t-1} in the $\Delta LGDP_t$ model. The selection of ARDL (2, 1 & 0) approach is based on AIC.					
Variables	Coefficients	Standard errors	T-ratios	P-values	Significance levels
Intercept term	-0.72	0.23	-3.08	0.00	1%
$\Delta LGDP_{t-1}$	0.69	0.14	5.00	0.00	1%
$\Delta LGDP_{t-2}$	-0.24	0.12	-1.95	0.06	7.5%
ΔLCO_{2t}	0.12	0.10	1.27	0.21	Insignificant
ΔLCO_{2t-1}	-0.34	0.09	-3.77	0.00	1%
ΔLEC_t	0.92	0.23	4.03	0.00	1%
ecm_{t-1}	-0.55	0.12	-4.61	0.00	1%

Diagnostic tests: χ^2 Autocorrelation = 0.22[0.64]; χ^2 Ramsey Reset = 2.69[0.10]; χ^2 Heteroscedasticity = 0.4[0.5] χ^2 Normality = 0.96[0.62]; $\overline{R}^2$ = 0.81; R^2 = 0.83; F-statistics = 11.77(0.00).

Notes: (1) Figures in parentheses represent the p-values of F-statistics. (2) Figures in brackets denote the p-values of the chi-square (χ^2). (3) AIC represents Akaike information criterion that calculate the lag length and orders. (4) The output sourced from Micro-fit econometric software package version *4.1*.

Table 4 also shows that LCO_{2t} is negatively related to the $LGDP_t$ model in the long-run and short-run at the 7.5% and 1% significance levels, respectively. That is, if there is 1% decreases in LCO_{2t}, the $LGDP_t$ model increases by 40% in the long-run and 34% in the short-run, and vice versa. These results contradict the earlier findings of Ang's (2008) paper in Malaysia.

Table 5. *Equilibrium Relationships Analyses for the LEC_t Model.*

41 observations used for estimating the long-run relationships in LEC_t model.					
Variables	Coefficients	Standard errors	T-ratios	P-values	Significance levels
Intercept term	0.98	0.07	13.85	0.00	1%
LCO_{2t-1}	0.36	0.07	4.87	0.00	1%
$LGDP_{t-1}$	0.44	0.08	5.31	0.00	1%

40 observations for estimating the short-run relationships and ecm_{t-1} in ΔLEC_t model.
The selection of ARDL (1, 2 & 2) approach is based on AIC.

Variables	Coefficients	Standard errors	T-ratios	P-values	Significance levels
Intercept term	0.61	0.12	5.08	0.00	1%
ΔLEC_{t-1}	0.38	0.14	2.80	0.00	1%
ΔLCO_{2t}	0.14	0.05	2.66	0.01	1%
ΔLCO_{2t-1}	0.19	0.06	2.97	0.01	1%
ΔLCO_{2t-2}	-0.11	0.06	-1.74	0.09	10%
$\Delta LGDP_t$	0.28	0.09	3.29	0.00	1%
$\Delta LGDP_{t-1}$	-0.25	0.12	-2.12	0.04	5%
$\Delta LGDP_{t-2}$	0.24	0.08	2.91	0.00	1%
ecm_{t-1}	-0.62	0.14	-4.51	0.00	1%

Diagnostic tests: χ^2 Autocorrelation = 0.79[0.98]; χ^2 Ramsey Reset = 1.18[0.3]; χ^2 Heteroscedasticity = 0.03[0.9] χ^2 Normality = 3.34[0.19]; $\bar{R}^2 = 0.85$; $R^2 = 0.87$; F-statistics = 12.37 (0.00).

Notes: (1) Figures in parentheses represent the p-values of F-statistics. (2) Figures in brackets denote the p-values of the chi-square (χ^2). (3) AIC represents Akaike information criterion that calculate the lag length and orders. (4) The output sourced from Micro-fit econometric software package version *4.1*.

The LCO_{2t} model requires the shortest period of time to restore the long-run equilibrium (i.e., about 1.52 years − one divided by the ecm_{t-1} coefficient (see Table 3), followed by the LEC_t model, (approximately 1.61 years, Table 5) and the $LGDP_t$ model, (approximately 1.82 years, Table 4). However, all the models passed the diagnostic tests (Tables 3, 4, and 5).

5.4. Environmental Kuznets curve hypothesis test

The EKC hypothesis stated that, as the GDP increases, CO_2 emissions also increase in first stage, and then start declining at a turning point. Figure 4 shows that the CO_2 emissions−GDP relationship seems to be trending in an upward (i.e., increasing) and started to decline temporarily at the turning point 25 (i.e., 5.8 metric tonnes per capita of CO_2 emissions and 1635 thousands of Ringgit Malaysia per capita of GDP).

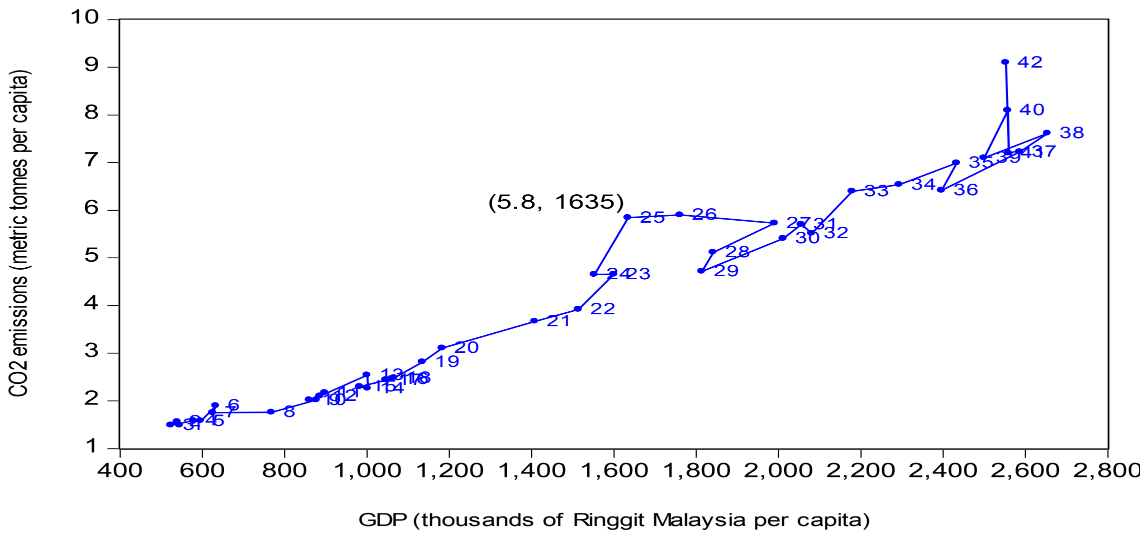

Figure 4. Enviromental Kuznets curve hypothesis in Malaysia for the 1971-2012 period.
Source: E-views econometric software package version 7.2.

Thus, the findings do not support the existence of EKC hypothesis in the Malaysian economy, especially in long-run. These results are in line with the findings of Arouri et al. (2012) in MENA countries' economies; Fodha and Zaghdoud (2010) in the Tunisian economy; and Halicioglu (2009) in the Turkish economy. However, the findings contradict the results of Saboori et al. (2012) in Malaysian economy. Specifically, they revealed an inverted U shape relationship between CO_2 emissions and GDP in long- and short-run.

6. Concluding Remarks

The present paper analyses the long-run and short-run relationships among CO_2 emissions, GDP per capita, and EC per capita in Malaysia for the [1971−2012] period. It employs KPSS (1996) test to detect stationary levels of variables, while the ARDL approach was used for testing the co-integration and estimating the equilibrium relationships. However, the results of KPSS test show that the investigated variables are stationary at *I(1)*. The findings of bounds F-statistics demonstrate that the variables in all models are co-integrated (i.e., LCO_{2t}, $LGDP_t$, and LEC_t). In addition, the paper's outcomes suggest that Malaysia is an energy−dependent country, as EC is positively associated with GDP in long-run and short-run. Therefore, Malaysian policy makers should focus on energy sector development, which in turn increases GDP. On the other hand, the results show that EC is positively associated with CO_2 emissions in the long-run and short-run. That is, the higher EC, which is necessary for higher GDP, increases the CO_2 emissions. The paper's outcomes are consistent with the earlier findings of Fodha and Zaghdoud (2010) and Halicioglu (2009) in relation to the inexistence of the EKC hypothesis in the Malaysian economy. The CO_2 emissions-GDP relationship is moving in the same direction (i.e., upward increasing) in the long-run. Thus, Malaysian policy−makers should continue in implementing a national green technology policy that ensures sustainable increases in GDP and EC, while reducing CO_2 emissions into the atmosphere. Indeed, future work could expand this paper by adding FDI inflows into the CO_2 emissions function, as this variable is the main engine of economic growth in emerging economies (e.g., Malaysia).

Acknowledgments

This work is dedicated to the author's family: Ibrahim, Amneh, Rasha, Noor, and Ahmad. The author gratefully acknowledges the financial assistance provided by Irbid National University, Jordan.

References

Alam, M.J., Begum, I.A., Buysse, J., Huylenbroeck, G.V., 2012. Energy consumption, carbon emissions and economic growth nexus in Bangladesh: Cointegration and dynamic causality analysis. Energy Policy 45, 217-225.

Ang, J.B., 2008. Economic development, pollutant emissions and energy consumption in Malaysia. Journal of Policy Modelling 30(2), 271-278.

Arouri, M.E., Youssef, A., M'henni, H., Rault, C., 2012. Energy consumption, economic growth and CO_2 emissions in Middle East and North African countries. Energy Policy 45, 342-349.

Bekhet, H.A., 2013. Assessing structural changes in the Malaysian economy: I-O approach. Economic Modelling 30, 126-135.

Bekhet, H.A., Othman, N.S., 2011. Causality analysis among electricity consumption, consumer expenditure, gross domestic product (GDP) and foreign direct investment (FDI): Case study of Malaysia. Journal of Economics and International Finance 3(4), 228-235.

Belloumi, M., 2009. Energy consumption and GDP in Tunisia: Cointegration and causality analysis. Energy Policy 37(7), 2745-2753.

Chang, C.C., 2010. A multivariate causality test of carbon dioxide emissions, energy consumption and economic growth. Applied Energy 87(11), 3533-3537.

Climate change Performance Index Report (2012), German watch, the European Union and the Barthel foundation, retrieved from: *http://germanwatch.org/en/download/7158.pdf*

Fei, L., Dong, S., Xue, L., Liang, Q., Yang, W., 2011. Energy consumption-economic growth relationship and carbon dioxide emissions in China. Energy Policy 39(2), 568-574.

Fodha, M., Zaghdoud, O., 2010. Economic growth and pollutant emissions in Tunisia: An empirical analysis of the environmental Kuznets curve. Energy Policy 38(2), 1150-1156.

Halicioglu, F., 2009. An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. Energy Policy 37, 1156-1164.

Hussain, M., Javid, M.I., Drake, P.R., 2012. An econometric study of carbon dioxide (CO2) emissions, energy consumption, and economic growth of Pakistan. International Journal of Energy Sector Management 6(4), 518-533.

Islam, F., Shahbaz, M., Ahmed, A.U., Alam, M. M., 2013. Financial development and energy consumption nexus in Malaysia: A multivariate time series analysis. Economic Modelling 30, 435-441.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y., 1992. Testing the null hypothesis of stationary against the alternative of a unit root. Journal of Econometrics 54, 159-178.

Menyah, K., Wolde-Rufael, Y., 2010. Energy consumption. pollutant emissions and economic growth in South Africa. Energy Economics 32(6), 1374-1382.

Ministry of Finance (2012), economic transformation policy report towards 2020 vision, retrieved from: *http://etp.pemandu.gov.my/annualreport/upload/Eng_ETP2012_01_Opening.pdf*

Narayan, P.K., Narayan, S., 2010. Carbon dioxide emissions and economic growth: Panel data evidence from developing countries. Energy Policy 38(1), 661-666.

Narayan, P.K., Popp, S., 2012. The energy consumption-real GDP nexus revisited: Empirical evidence from 93 countries. Economic Modelling 29(2), 303-308.

Ouedraogo, N.S., 2013. Energy consumption and economic growth: Evidence from the economic community of West African States (ECOWAS). Energy Economics 36, 637-647.

Pao, H.T., Tsai, C.M., 2010. CO_2 emissions, energy consumption and economic growth in BRIC countries. Energy Policy 38(12), 7850-7860.

Park, J., Hong, T., 2013. Analysis of South Korea's economic growth, carbon dioxide emission, and energy consumption using the Markov switching model. Renewable and Sustainable Energy Reviews 18, 543-551.

Pesaran, B., Pesaran, M.H., 2009. Time series econometrics using Microfit 5.0 (first edition). England: Oxford University Press.

Pesaran, M.H., Shin, Y., Smith, R.J., 2001. Bounds testing approach to the analysis of level relationships. Journal of Applied Econometrics 16(3), 289-326.

Saboori, B., Sulaiman, J., Mohd, S., 2012. Economic growth and CO_2 emissions in Malaysia: A cointegration analysis of the environmental Kuznets curve. Energy Policy 51, 184-191.

Shahbaz, M., Zeshan, M., Afza, T., 2012. Is energy consumption effective to spur economic growth in Pakistan? New evidence from bounds test to level relationships and Granger causality tests. Economic Modelling 29(6), 2310-2319.

Shahiduzzaman, M., Alam, K., 2012. Cointegration and causal relationships between energy consumption and output: Assessing the evidence from Australia. Energy Economics 34(6), 2182-2188.

Soytas, U., Sari, R., 2009. Energy consumption, economic growth, and carbon emissions: Challenges faced by an EU candidate member. Ecological Economics 68(6), 1667-1675.

UNFCCC (2009), United Nations Copenhagen Climate Change Conference, framework convention on climate change, retrieved from: *http://unfccc.int/meetings/copenhagen_dec_2009/meeting/6295.php*

Wang, K.M., 2012. Modelling the nonlinear relationship between CO_2 emissions from oil and economic growth. Economic Modelling 29(5), 1537-1547.